EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	3834931	ID or identif$8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:27
L2	2689819	module or mode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:27
L3	126141	1 with 2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:28
L4	3141280	monitor$3 or track$3 or audit$3 or target$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:29
L5	4149954	log or history or performance or activit$3 or service	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:29
L6	290830	4 with 5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:30
L7	23090	3 and 6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:30

EAST Search History

L8	1668767	register$3 or registr$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:30
L9	2673900	service or activit$3 or usage	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:31
L10	60018	8 with 9	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:31
L11	3851	7 and 10	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:31
L12	316671	(match$3 or exist$3) with (request$3 or requir$6 or inquir$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:32
L13	1905	11 and 12	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:32
L14	3663251	proxy or proxies or represent$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:33

L15	6783396	object or service or request$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:34
L16	272963	14 with 15	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:35
L17	1160	13 and 16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:36
L18	147802	defin$5 with 2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:36
read L19	605	17 and 18	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/07/26 11:37

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	12475	((ID or identif$8) with (module or mode)).clm.	US-PGPUB	OR	ON	2007/07/26 11:16
L2	14566	((monitor$3 or track$3 or audit$3 or target$3) with (log or login or history or performance or activit$3 or service)).clm.	US-PGPUB	OR	ON	2007/07/26 11:18
L3	68648	"s1" and "s2"	US-PGPUB	OR	ON	2007/07/26 11:18
L4	3512	((register$3 or registr$3) with (service or activit$3 or usage)).clm.	US-PGPUB	OR	ON	2007/07/26 11:19
L5	42785	"s3" and "s4"	US-PGPUB	OR	ON	2007/07/26 11:19
L6	579	1 and 2	US-PGPUB	OR	ON	2007/07/26 11:19
read L7	30	6 and 4	US-PGPUB	OR	ON	2007/07/26 11:19

```
? show files
File  15:ABI/Inform(R) 1971-2007/Jul 25
         (c) 2007 ProQuest Info&Learning
File  16:Gale Group PROMT(R) 1990-2007/Jul 25
         (c) 2007 The Gale Group
File 148:Gale Group Trade & Industry DB 1976-2007/Jul 23
         (c)2007 The Gale Group
File 160:Gale Group PROMT(R) 1972-1989
         (c) 1999 The Gale Group
File 275:Gale Group Computer DB(TM) 1983-2007/Jul 23
         (c) 2007 The Gale Group
File 621:Gale Group New Prod.Annou.(R) 1985-2007/Jul 20
         (c) 2007 The Gale Group
File   9:Business & Industry(R) Jul/1994-2007/Jul 20
         (c) 2007  The Gale Group
File  20:Dialog Global Reporter 1997-2007/Jul 25
         (c) 2007 Dialog
File 476:Financial Times Fulltext 1982-2007/Jul 25
         (c) 2007 Financial Times Ltd
File 610:Business Wire 1999-2007/Jul 26
         (c) 2007 Business Wire.
File 613:PR Newswire 1999-2007/Jul 26
         (c) 2007 PR Newswire Association Inc
File 624:McGraw-Hill Publications 1985-2007/Jul 25
         (c) 2007 McGraw-Hill Co. Inc
File 634:San Jose Mercury  Jun 1985-2007/Jul 24
         (c) 2007 San Jose Mercury News
File 636:Gale Group Newsletter DB(TM) 1987-2007/Jul 24
         (c) 2007 The Gale Group
File 810:Business Wire 1986-1999/Feb 28
         (c) 1999 Business Wire
File 813:PR Newswire 1987-1999/Apr 30
         (c) 1999 PR Newswire Association Inc
File   2:INSPEC 1898-2007/Jul W3
         (c) 2007 Institution of Electrical Engineers
File  35:Dissertation Abs Online 1861-2007/Jul
         (c) 2007 ProQuest Info&Learning
File  65:Inside Conferences 1993-2007/Jul 25
         (c) 2007 BLDSC all rts. reserv.
File  99:Wilson Appl. Sci & Tech Abs 1983-2007/Jun
         (c) 2007 The HW Wilson Co.
File 256:TecInfoSource 82-2007/Aug
         (c) 2007 Info.Sources Inc
File 474:New York Times Abs 1969-2007/Jul 26
         (c) 2007 The New York Times
File 475:Wall Street Journal Abs 1973-2007/Jul 26
         (c) 2007 The New York Times
File 583:Gale Group Globalbase(TM) 1986-2002/Dec 13
         (c) 2002 The Gale Group
? ds

Set      Items   Description
S1     3424686   ID OR IDS OR IDENTIFICATION? ? OR IDENTIFIER? ? OR IDENTITY
               OR IDENTITIES
S2     2900685   MODULE? ? OR MODE OR MODES
S3       21201   S1 (8N) S2
S4    18555968   MONITOR??? OR TRACK??? OR AUDIT??? OR TARGET???
S5    16888771   LOG OR LOGS OR LOGIN OR LOGINS OR HISTORY OR HISTORIES OR -
             PERFORMANCE
```

S6	638322	S4 (8N) S5
S7	46499277	PERFORMANCES OR ACTIVITY OR ACTIVIES OR SERVICE OR SERVICES
S8	1639988	S4 (8N) S7
S9	2171177	S6 OR S8
S10	1400	S3 AND S9
S11	10860871	PROXY OR PROXIES OR PROXYS OR REPRESENT?????
S12	423	S10 AND S11
S13	5888717	REGISTER??? OR REGISTR???

S14	46568371	SERVICE OR SERVICES OR ACTIVITY OR ACTIVIES OR USAGE OR USAGES
S15	413164	S13 (8N) S14
S16	17	S12 AND S15
S17	12	S16 NOT PY>2002
read S18	8	RD (unique items)
?		

? t s18/medium,k/all

18/K/1 (Item 1 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)

02548348 208457831
Calling up culture: Information spaces and information flows as the virtual dynamics of inclusion and exclusion
Little, Stephen; Holmes, Len; Grieco, Margaret
Information Technology & People v14n4 PP: 353-367 2001
ISSN: 0959-3845 JRNL CODE: OTP
WORD COUNT: 7018

...TEXT: as intense, as evidenced by the controversy over the US Smithsonian Institute's 50th anniversary **representation** of the atomic raids on Japan (Mobile, 1995). Significantly, both sides of the dispute have...

...newcomers may enter into each viewpoint[4]. This paper examines the issues of power and **representation** being encountered as new forms of archiving are accessed from the margins.

The new information...arena through the appropriation of the technologies of globalisation. For Castells, such "communal resistance ideologies" **represent** a challenge to the dominant logic of the network society (Castells, 1997, p. 359). Carlin...
...that Subcommandante Marcos lacks authenticity in relation to the dispossessed whom the Zapatistas claim to **represent** . This paper suggests that authenticity can in fact be maintained in the new media. Building...a logical step onwards from the electronically-monitored home confinement practices or the in-flight **monitoring** of civil aircraft **performance** which were well established by the end of the 1990s. In these cases, monitoring may be conducted on a different continent from the **activity monitored** (see Aungles, 1994,1995).

Much has been made of the way in which members of...

...The technology's ability to provide for archiving while enabling instant access, potentially affords novel **modes** for the maintenance of **identity** claims. Thus, in the employment arena, resumes and curricula vitae, in summary form and in...

...been "spoiled" and reputation lost, the technology provides for possible relational repositioning, i.e. the **representation** of self in relation to others, to past self and to future self.

At the...
...the use of electronic communication forms in development management. E-commerce focused on craft goods **represents** a form of virtual tourism which can generate wealth for indigenous communities which are either... scale of the new interactivity in communications in Indonesia as about 80,000 Internet users **registered** via Internet **Service** Providers in Indonesia. Research into Indonesia revealed a number of IT associations: APKOMINDO; ASPILUKI; Asricitra...

...of self) and telecommunications is very evident in Indonesia. Currently there are more than 40 **registered** Internet **Service** Providers (ISP) in Indonesia, mostly operated in Jakarta although around 20 are in difficulty due...to construct, within this plethora of the familiar-alien, a local

sensibility distinct from that **represented** in US-Euro popular culture. On a national and regional level, Africanisation is not a...

18/K/2 (Item 2 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)

00990588 96-39981
From increasing revenues to controlling costs: Benchmark data for strategic planning
Anonymous
Healthcare Financial Management Special Report Supplement PP: 1-16 1995
ISSN: 0735-0732 JRNL CODE: HFM
WORD COUNT: 6106

...TEXT: of laboratory cost and utilization include:

* Better cost and utilization performers tend to use batch **mode** testing and bar code specimen **identification** systems.

* Interfaced laboratory instrument information systems tend to be associated with better cost performance.

* Lower...areas;

* Poorer performers in both cost and service utilization tend to provide outpatient dietetic counseling **services** ; and
* Including a **registered** dietetic technician's hours as a department labor expense is associated with higher overall department...

...found in lower cost departments;

* Performance of some ancillary tasks (eg, maintenance of a tumor **registry** or provision of transcription **services** to other departments) is associated with departments having higher labor costs; and

* Decentralized physical locations...adjust staffing levels to workload demands. Also, in regard to claims preparation production, the patient **representative** model of staff assignment appears to have been more closely associated with better performers than...

...to be associated with lower costs in admitting and registration; and

* Use of the patient **representative** model for claims preparation tends to be associated with lower labor costs in patient accounting...of data for the analyses in this publication. MECON also offers MECON-OPTIMIS (an internal **monitoring** system designed to **track** productivity, costs, and **service** quality) and MECON-Advisory Operations Improvement Consulting. Since 1983, MECON has provided information to the...

18/K/3 (Item 3 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)

00642870 92-57810
Global System for Mobile Communications
Beaudry, Michelle; Parker, Jerry
Telesis n94 PP: 52-69 Jul 1992

ISSN: 0040-2710 JRNL CODE: TLS
WORD COUNT: 9581

...TEXT: advanced ISDN-type services) as they move from one European country to another. This capability **represents** a radical departure from the past, because historically cellular subscribers in Europe have faced a ...for use in their networks.

While specific to a digital cellular implementation, the GSM standards **represent** the most advanced specifications for the ubiquitous provision of the mobility features that are fundamental to the realization of Personal Communications **Services** (PCS). These features include location **tracking** and mobile call routing.

To provide true access-independent and location-independent services, PCS must...base station system (which includes the base transceiver station and the base station controller), mobile- **services** switching center (MSC), home location **register** (HLR), visitor location register (VLR), authentication center, and equipment identity register.

The mobile stations (the...

...They are partitioned functionally and physically into two units: the mobile equipment, and the subscriber **identity** **module** (SIM) card.

The mobile equipment communicates with the base station system over the radio link...equal access to the information, thereby making efficient use of network resources and optimizing network **perform**ance .

The operations and maintenance center provides dynamic **monitoring** and control of operations and maintenance over its geographic area, and interacts with a network...automatically issued a temporary mobile subscriber identity (TMSI) when they enter a new area and **register** for **service** . The TMSI--which is changed periodically while the subscriber remains in the area--is used...

...the network and is used for billing purposes. The TMSI is broadcast when the subscriber **registers** for **service** in a new area. Using a temporary identifier instead of the permanent IMSI makes it more difficult for eavesdroppers to track the location of subscribers and **audit** their calls. TMSIs are used by a mobile- **services** switching center (which, among other things, switches and routes calls from the public switched telephone...

...interface to the network and implements the algorithm for radio-link encryption; and the subscriber **identity** **module** (SIM) card (a "smart card" about the size of a credit card). which has an...

...key (Kc). The Kc computed by the authentication center is sent to the visitor location **register** . The mobile- **services** switching center retrieves Kc from the visitor location **register** and forwards it to the base transceiver station, where it is stored for subsequent use...When a mobile station enters an area outside its home subscription area, the visitor location **register** associated with the mobile- **services** switching center in the new area initiates a protocol that extracts the mobile's temporary...

...GSM (Global System for Mobile Communications) standards are secific to digital cellular networks, they currently **represent** the world's most advanced specifications for providing mobility features--such as location tracking--that...

...among others. Particularly important for PCS are the network aspects for provisioning subscribers and their **services** , as well as for **tracking** their current location in the network.

As Diagram A shows, a GSM network comprises a...from cellular systems, as well as investigate the sharing of infrastructure, such as home location **registers** , base stations, and the mobile- **services** switching center, between PCN and GSM cellular networks.

BOX 4. BNR DEVELOPS UNIQUE TOOL FOR...for detailed examination. The simulator displays results geographically by averaging them within small grid regions (**representing** 50-or 100-meter squares), as well as for each base station.

Variations in traffic...

18/K/4 (Item 1 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

07707176 Supplier Number: 64254691 (USE FORMAT 7 FOR FULLTEXT)
QUALCOMM CDMA Technologies Delivers World's First CDMA Multimedia Chipset and System Software Solution for Handsets.
Business Wire, p2063
August 16, 2000
Language: English Record Type: Fulltext
Document Type: Newswire; Trade
Word Count: 1388

... QCT) MSM3300(TM) Mobile Station Modem (MSM(TM)) chipset samples and system software. This product **represents** the world's first multimedia-capable CDMA chipset and features the highest level of integration...

...position location features in very small and cost-effective form-factors.
"The MSM3300/IFR3300 solutions **represent** QUALCOMM's ongoing leadership in wireless technology and our commitment to help manufacturers begin immediate...

...the gpsOne(TM) position-location solution featuring SnapTrack(TM) technology, Bluetooth connectivity capabilities, Removable User **Identity Module** (R-UIM) controller (CDMA Subscriber **Identity Module** (SIM) controller), and multimedia features such as Qtunes(TM) Moving Picture Experts Group (MPEG-1...

...software and services, including personalized navigation information, area-specific weather forecasts, traffic reports and commercial **tracking services** , as well as a broad range of e-commerce and entertainment applications, including mobile yellow...and OmniExpress are trademarks of QUALCOMM Incorporated. Globalstar is a trademark of Loral QUALCOMM Satellite **Services** , Incorporated. Windows is a **registered** trademark of Microsoft Corp. Macintosh is a registered trademark of Apple Computer Inc. All other...

18/K/5 (Item 1 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB

0020169118 SUPPLIER NUMBER: 94541866 (USE FORMAT 7 OR 9 FOR FULL TEXT)

China IT and Telecom Report (Daily News Briefs: NOV 22, 2002).

China IT & Telecom Report, NA
Nov 22, 2002
LANGUAGE: English RECORD TYPE: Fulltext
WORD COUNT: 26378 LINE COUNT: 02113

... GSM mobile phone subscribers increased to 37.026 mln as of October 31, 2002. This **represents** an addition of 0.952 mln, or 2.63%, in October and 10.059 mln...

...2002
Source: China Unicom (HK)
As of the end of October, China Unicom (HK) recorded **registered** Internet access **service** subscribers of 6.456 mln, an addition of 126,000 in the month. Despite a...

...development of broadband. The plastics, chemicals, metals, biomedicine, automobile, transportation and electronics industries are all **represented** .

Over 40% of the country's population and GDP lies in the area, said Luo...s TV advertising expenditure will reach RMB 20 bln (USD 2.41 bln) in 2002, **representing** over 40% of China's entire advertising market. CCTV is by far the dominant player with advertising revenues of RMB 5.4 bln (USD 652 mln) in 2001, **representing** a 32% market share of China's total TV advertising spend.
INTERNET
Tom.com forms...annually for the first three years.
As a print media advertising agency in China, Mingsheng **represents** over 266 periodicals and magazines and 23 newspapers nationwide, according to Tom.com, and monthly...

...mln, USD 1.3 less than last quarter. Revenues from China increased 13%, and now **represent** 37% of the company's overall revenue.
The company says it now has 369,885...

...not expect any big sales increase (of smart phones) next year in China. But it **represents** a trend in future," said Gu Lei, CEO of CECT.
In addition to smart phones...inspection of textile fabrics and industrial webs announced to Interfax that it has opened a **representative** office in Shanghai. EVS has been operating in China for the past several years and...
...years in the European and US textile industries," said Mr. Ken Chen EVS' China Chief **Representative** .
SOFTWARE
CIC furthers expansion in China's railway industry with two new contracts for e...

...its InkTools bio-metric electronic signature and office automation tools to the SSID. This contract **represents** the adoption of CIC technologies by the third of the 4 government survey and design...Half-year revenue of the business amounted to HKD 4.863 bln (USD 625 mln), **representing** a growth of 25.6% over that of the same period last year.
Digital China...the vast majority of the worldCOs mobile phones, banks across the globe can deploy the **service** immediately with minimum investment as MobilewayCOs Mobile Transaction **Tracker** does not require any modification to the handset or to the userCOs SIM card.
MobilewayCOs solution works by managing a request and response

tracking mechanism. For each new transaction, a unique **service** number is dynamically allocated in order to originate the message sent to the consumer and...

...the customer with a very simple and interactive tool to define and set up the **service** as desired.

- A **monitoring** and reporting module which enables customers to manage & measure the newly launched service on a day-to-day basis

MobilewayCOs provisioning interface allows customers to create their own accounts or **services** with all the desired features, choose their **target** countries and operators, the tariffs and the net pay back they wish to get from...

...systems, based on GSM cellular technology providing voice and narrow band data services. The Subscriber **Identity Module** (SIM) network architecture is composed of mobile payment made by mobile phones and mobile Point...

18/K/6 (Item 2 from file: 148)

DIALOG(R)File 148:Gale Group Trade & Industry DB

05429586 SUPPLIER NUMBER: 11124243 (USE FORMAT 7 OR 9 FOR FULL TEXT)

Slot-O controllers meet VXI-system needs. (choosing a controller for a VME extensions for instrumentation system) (includes related article on VXI-controller basics)

Quinnell, Richard A.

EDN, v36, n16, p93(7)

August 5, 1991

ISSN: 0012-7515 LANGUAGE: ENGLISH RECORD TYPE: FULLTEXT; ABSTRACT

WORD COUNT: 2206 LINE COUNT: 00181

... data before processing. Software also handles the word-serial protocol's handshaking by polling status **registers** between word transfers. All this software **activity** slows down communications.

Hewlett-Packard reported some test results that demonstrate the impact of command...may not be fast enough if your application requires register-based speeds.

MXIbus external controllers **represent** a hybrid solution. The MXIbus extends the VXIbus outside the cage, which lets an external...

...physically in the VXI cage. Currently, only National Instruments has MXIbus-based controllers.

The controller- **performance** issue is a moving **target** , however. SCPI and Tektronix/Colorado Data Systems' smart registers **represent** efforts to bring register-based speeds to message-based systems. Hewlett-Packard has firmware, which...

...slot-0 card provides two system resources: a 10-MHZ ECL system clock (CLK10) and **module - identification** (MODID) lines. The MODID lines let the Resource Manager, a software element the VXIbus specification...

18/K/7 (Item 3 from file: 148)

DIALOG(R)File 148:Gale Group Trade & Industry DB

04594859 SUPPLIER NUMBER: 08555226 (USE FORMAT 7 OR 9 FOR FULL TEXT)

Direct marketing software guide 1990. (includes related articles on

providing list processing to retailers, calculating postal rates, and writer's block) (buyers guide)

Direct Marketing, v53, n2, p29(22)
June, 1990
DOCUMENT TYPE: buyers guide ISSN: 0012-3188 LANGUAGE: ENGLISH
RECORD TYPE: FULLTEXT; ABSTRACT
WORD COUNT: 15543 LINE COUNT: 01388

... assignments based on territory and product responsbility, personalized letters of inquires, sales lead sheets and **performance** reports. It also **monitors** salesperson's follow-up effectiveness.

Specs: PC-based, DOS 2 and 3 series. Requires 640K...higher.

Training/Service: Tutorial provided via video, detailed manual and on-site training by sales **representative** . Toll-free help line also available.

Users: Several users in the insurance, business services, banking...

...2251; 314/569-3450

.Package features: This data storage and report generation package provides detailed **tracking** of individual agent and group **performance** . It **tracks** quality, productivity and reliability data to present view of performance factors and presents information in...and Finder 6.0 required as is one diskette drive and a hard drive.

Training/ **Service** : Unlimited free phone support for **registered** users. BBS support through Compuserve FoxForum.

Price: $495 for single Mac, $695 for network version...2.1 or higher. Supports Hercules CGA, EGA, Super EGA and VGA display graphics.

Training/ **Service** : Unlimited free phone support for **registered** users. BBS support through Compuserve FoxForum.

Price: $295

List Management/Database: FOXPRO Fox Software, Inc...

...512K required, 640K recommended. One diskette drive and one hard drive required. Mouse recommended.

Training/ **Service** : Unlimited free phone support for **registered** users. BBS support through CompuServe FoxForum.

Price: $795 for single PC, $1,095 for network...in a real-time environment to ensure that quarter- or half-hourly plans consistently deliver **targeted** **service** levels. Software also provides a series of **log** reports **tracking** daily activities.

Specs: Requires 100% compatibility with IBM/AT, IBM PS/2 Model 30-286 ...offers ways to manage business contacts, including a simple method to store names and addresses, **track** **history** , search and **target** a client base, write letters, increase phone effectiveness and guarantee follow ups. Also features a...

...compatible and 450K of memory. Operating systems are: MVS/VXA, MVS/SP, VSE/SP. TP **Monitors** : CICS, IMS/DC.

Training/ **Service** : Three days included with installation.

Users/Installation: More than 600 users.

Price: $14,000-$89...

...development of the database engine, an application is then created that can include the following **modules** : customer/prospect **identification** and **tracking** , segmentation, **activity** rewards, communication and recognition.

Specs: PC-based; company also has a service bureau and can...

18/K/8 (Item 4 from file: 148)

03929442 SUPPLIER NUMBER: 07755147 (USE FORMAT 7 OR 9 FOR FULL TEXT)

Direct Marketing software guide. (guide for software packages for marketing)

Rose, Matthew; Castellano, Brenda; Di Bella, Lori

Direct Marketing, v52, n2, p53(23)
June, 1989
ISSN: 0012-3188 LANGUAGE: ENGLISH RECORD TYPE: FULLTEXT; ABSTRACT
WORD COUNT: 21429 LINE COUNT: 01876

... DOS 2.0 or higher. Ver. 3.01 requires 512K disk space; color and monochrome **monitor** supported. Training/ **Service** : Manual and phone support available. Price: $695. Miscellaneous, Desk Top Publishing: HEADLINER The Salinon Corporation...

...1.5 requires DOS 2.0 or higher and 256K RAM; printer is recommended. Training/ **Service** : Free telephone support to all **registered** users. Price: $150, plus $2 shipping.

I Miscellaneous: THE IDEA GENERATOR PLUS Experience in Software...

...program, peer to peer printing, group scheduling with automatic notification, network file sharing using graphic **representation** , net-wide dynamic linking of spreadsheet data. Specs: System runs on 10MB hard drive with...AT, PS/2 or 100% compatible. Ver. 1.6 requires 640K hard drive space. Training/ **Service** : Telephone support available; maintenance free to **registered** users. Users/Installations: Users in various industries. Price: $195

List Management/Database, Mailing System: MERGE...development of the database engine, an application is then created that can include the following **modules** : customer/prospect **identification** and **tracking** , segmentation, **activity** rewards, communication and recognition. Specs: PC-based; company also has a service bureau and can...Compaq 386, with Gomegabyte hard disk, 4 CD ROM Drives, and extra high resolution color **monitor** . Training/ **Service** : Manual, phone hotline, on-site, or vendor-site training. Price: Call for price.

List Management...

...presort, carrier routing, occupant mail and list enhancements. It handles literature and product fulfillment, including **monitoring** inventory levels, backorder processing, **activity** reports, order entry, receipt **tracking** and the production of packing slips, shipping labels and credit card slips. In addition, a...reports, statistical information and follow-up data. Plug-in integrated modules are available for: lead **tracking** , telemarketing, products quotes, sales call **activity** , trade shows, market research, warranty/product registration and literature. Inventory management. A complete system for...

...386 PC, DOS 3.0 or higher; 640K RAM; 20MB hard disk, EGA or VGA **monitor** . Training/ **Service** : On-site customization and support plus free 800 telephone support. Users/Installations: Used by top...mail, telemarketing and analysis, single keystroke switching between activities, literature fulfillment with picking list, sales **history** **tracking** , sales commission report, unlimited background test, complete analysis and reporting, form letter merge, interoffice messaging...incremental pricing, credit card updates, profit stats per video. It also prints mailing labels and **tracks** membership **histories** . Specs: PC-compatible with MS DOS. Training/Service: Manual and telephone assistance provided. Price: $995...

...ASCII format). Specs: Version 2.1 requires DOS 2.1 or higher; 256K RAM.
Training/ **Service** : Toll free number support to all **registered** users.
Price: $99 plus $2 shipping with a 30 day money-back guarantee (less $20...
?

Display 00642870/9

00642870 92-57810

Global System for Mobile Communications

Beaudry, Michelle; Parker, Jerry

Telesis n94 PP: 52-69 Jul 1992 CODEN: TLSSAD ISSN: 0040-2710
JRNL CODE: TLS
DOC TYPE: Journal article LANGUAGE: English LENGTH: 18 Pages
SPECIAL FEATURE: Diagrams
WORD COUNT: 9581
COMPANY NAMES:
Bell Northern Research Ltd (DUNS:20-578-5983)
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ABSTRACT: The inadequacies and inconveniences of the fragmented structure of European cellular systems are being addressed through the deployment of digital cellular networks that are based on Global System for Mobile Communications (GSM) standards. Northern Telecom and BNR are playing an important role in bringing the benefits of pan-European roaming, improved service, and higher capacity to European countries by developing several key network elements for introduction into GSM networks. The key GSM network elements being developed include: 1. a mobile-services switching center called the DMS-MSC, 2. a visitor location register, 3. a home location register, 4. an authentication center, and 5. a transit switching center. All of these GSM products are being implemented through software extensions to Northern Telecom's proven DMS SuperNode switching system platform. With this flexible architecture, GSM development will allow for mobility systems to support large-scale Personal Communications Services networks.

TEXT: Within the next few years, millions of cellular subscribers in Europe will be able to receive uninterrupted telecommunications services (including advanced ISDN-type services) as they move from one European country to another. This capability represents a radical departure from the past, because historically cellular subscribers in Europe have faced a patchwork of incompatible cellular technologies that have prevented them from using their cellular handsets in many countries other than their own.

The inadequacies and inconveniences of this fragmented structure are being addressed through the deployment of digital cellular networks that are based on GSM (Global System for Mobile Communications) standards. Under GSM, all mobile stations (the handsets) will comply with a common digital time division multiple access (TDMA) radio interface, and will be compatible with all of Europe's national GSM networks. (For more information on TDMA, see page 38.) Because these networks will be able to exchange service and location information about mobile subscribers and mobile stations, subscribers will be able to roam freely within national GSM networks, and from one European GSM network to another.

Work on the specifications for GSM standards began in 1982, initiated by a group within the European Telecommunications Standards Institute (ETSI). Originally called the Groupe Speciale Mobile (hence the acronym GSM), it is

now known as the Special Mobile Group. It was formed specifically to develop the specifications for a pan-European mobile cellular system. The European Community pushed to ensure the emerging GSM standards would become unified across Europe, and allocated the common spectrum needed to make it happen.

By 1990, the national telecommunications administrations and cellular network operators in 17 European countries had signed a memorandum of understanding agreeing to deploy digital cellular systems built to GSM specifications. These countries include Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Sweden, Spain, Switzerland, Turkey, and the United Kingdom. GSM standards are also being used by other groups, including North American and Japanese standards bodies, as a model for their own digital cellular network architectures and standards.

The GSM standards are more than 5,000 pages long and detail the complete specifications for a common digital cellular network including the network architecture, protocols, procedures, components, and system requirements (Box 1).

In developing the GSM specification, the ETSI GSM standards body adopted many technologies that have already proven their value in other telecommunications environments. Common Channel Signaling system no. 7 (CCS7), for example, was chosen as the transport standard to carry services across GSM networks. The robust CCS7 transport capability, together with ISDN (Integrated Services Digital Network) signaling, will deliver to GSM subscribers a number of supplementary services beyond those of basic telephony. These services include low-speed data, calling-line identification, and short message services.

In addition to these benefits, GSM--as with all digital cellular technologies--provides more channels per radio frequency and uses smaller cells than its analog counterparts. As a result of this increased spectral efficiency, GSM will service a larger subscriber base and reduce congestion in large cities. This capability is significant considering that industry sources estimate that by 1995 European GSM digital cellular systems will serve from 4 to 12 million subscribers, considerably more than the 2.4 million subscribers who were serviced by European analog cellular networks in 1991.

NORTHERN TELECOM'S GSM PRODUCTS

Northern Telecom and BNR are playing an important role in bringing the benefits of pan-European roaming, improved service, and higher capacity to European countries by developing several key network elements for introduction into GSM networks. These products will provide GSM cellular operators and users with a robust, high-capacity, and feature-rich platform that exceeds GSM performance requirements and delivers the full range of GSM services. Moreover, through strict adherence to GSM's open interface specifications--including CCS7 and ISDN --these products will interwork with other elements in the GSM network, including the base station systems and mobile stations of any manufacturer who conforms to GSM standards.

The key GSM network elements being developed by BNR and Northern Telecom include:

* a mobile-services switching center (called the DMS-MSC), which performs switching, routing, call-control, charging, and accounting functions, provides supplementary ISDN-type services, and controls interworking with the public switched telephone network and other MSCs in the GSM network;

* a visitor location register (VLR), which temporarily stores data about subscribers and mobile stations while they are active in the area served by the associated and located DMS-MSC;

* a home location register (called the DMS-HLR), a centralized database that stores information associated with each mobile user. This information includes the subscriber's service profile, location, and subscription and billing options;

* an authentication center (AUC), which is a database that generates encryption keys for encrypting voice, data, and signaling transmissions, as well as security-related parameters used by the DMS-MSC to verify that mobile users are authorized to use the system (Box 2); and

* a transit switching center, an enhanced DMS-100 service switching point that includes the gateway MSC capability, which controls the routing of calls to GSM subscribers by providing the capability to query the HLR as part of the call-routing sequence.

All of these GSM products are being implemented through software extensions to Northern Telecom's proven DMS SuperNode switching system platform, which offers a number of benefits. (For more information on DMS SuperNode, see Telesis 1988. no. 2, pp. 4-27.)

The DMS SuperNode, for example, supports an open network architecture via such industry-standard protocols as CCS7, ISDN primary rate access. and X.25, so that it can interwork with other manufacturers' equipment and service. This open architecture has created the signaling platform for the GSM product line.

HIGH-CAPACITY PLATFORM

The proven DMS SuperNode architecture also provides the high-capacity transaction processing engine needed to support message-intensive GSM call-processing and mobility-management features, and the sophisticated interface protocols that support these messages. The capacity of SuperNode--the highest in the telecommunications industry--is needed in a GSS network for two critical reasons.

One is to handle the heavy processing load imposed on network elements by the new mobility functions. Almost every call to a mobile subscriber, every request for service, and every location update generates an exchange of messages between the MSC, the visitor location register, and the network databases, such as the HLR and the authentication center. These messaging demands go far beyond what is required in wireline networks, or even existing cellular networks. Moreover, GSM network elements must have the capacity to handle sudden spikes in traffic, which may occur, for example, at the end of a major concert, when a large number of subscribers turn their mobile units back on.
The second major motivator for additional processing capacity is the need to accommodate the CCS7 and ISDN signaling protocols specified in the GSM standards. These protocols are inherently more complex than conventional communications links because of the added functionality and robustness they provide. Additional functionality includes the set up of encryption messages, the authentication of users, the allocation and set up of radio links, and the allocation of terrestrial channels, among others.

For example, GSM specifies the use of a standard ISDN-based A-interface between the MSC, the base station system, and the mobile stations. Much more message-intensive than conventional non-ISDN protocols, the

A-interface provides a unique marriage of ISDN-based call-control signaling with CCITT (International Telegraph and Telephone Consultative Committee) CCS7 Signaling Connection Control Part (SCCP) and Message Transfer Part (MTP) signaling to carry the ISDN messages between the DMS-MSC and the mobile station (via the base station system). This marriage enables the delivery of such supplementary GSM services as low-speed data and short-text messages.

Given the heavy processing demands placed on GSM network elements by the complex call-processing, mobility, and signaling protocols, the DMS SuperNode is the ideal hardware technology platform for the main elements of the network--the DMS-MSC and co-located visitor location register, and the DMS-HLR. Moreover, the close association of the MSC and HLR within the DMS SuperNode architecture provides a network infrastructure that will enable network operators to add new features and services to their systems in a coordinated manner as new standards and capabilities are developed (Figure 1). (Figure 1 omitted)

The DMS SuperNode platform has the necessary capacity to allow the DMS-HLR to be configured as a central node within the GSM network. Storing all subscriber information at a single centralized node simplifies administration for network operators. Alternatively, the DMS-HLR function can be distributed across multiple nodes, if the service provider wants to distribute the HLR function for extremely large networks or to more efficiently utilize existing CCS7 signaling links.

The flexibility of the DMS SuperNode technology platform also enables the VLR either to be integrated with DMS-Core--the main processing engine of SuperNode--to maximize real-time efficiency, or to be placed in an application processor separate from the DMS-Core to accommodate capacity growth in the network. (DMS-Core, a major architectural component of DMS SuperNode, performs call-processing and system control functions.) Currently, the visitor location register can be engineered to support from 10,000 to 150,000 subscribers, in increments of 10,000.

DMS-MSC

Using the DMS SuperNode as the hardware technology base, BNR is adding extensions to the DMS software to support the call-processing and mobility functions needed in a GSM network. The new call-processing software for the DMS-MSC differs somewhat from that used to support lines or trunks in a wireline network. Traditional call processing links subscriber data--such as the subscriber's telephone number--to a physical interface (the telephone line or trunk) on the network. By contrast, there is no permanent physical link between the mobile station and the DMS-MSC.

Instead, when the mobile station roams into the serving area of a DMS-MSC, it sends a location update message to the new DMS-MSC, which, in turn, adds a database entry to the VLR. No physical resource, however, is associated with the database entry at that time. It is only during call setup that a terrestrial voice resource becomes associated with the mobile station. The resource, in this case, is a voice channel on a 2-megabit-per-second (Mbit/s) PCM-30 transmission link between the DMS-MSC and the base station system. (The North American equivalent of the CCITT standard PCM-30 transmission system is the 24-channel DS-1.) While this arrangement provides efficient use of network resources, the fact that mobile stations move about within the network and that calls must be switched between different serving areas places extra demands on the call-processing software.

To minimize the impact of mobile station movements on the software, the

DMS-MSC software architecture provides layered, functional separations between mobile subscriber services processing, mobility management processing, and subscriber data. These separations help reduce software complexity. Specific responsibilities are isolated to the individual software components; for example, subscriber services processing provides such features as multiparty conferencing: mobility management supports handover and transmission link control, and subscriber data is kept in the VLR. In fact, a complete handover that requires changes in the physical connections (as discussed in Figure 2) is completed between mobility-management peers in the MSCs and base station systems without knowledge of the subscriber services processing layer.(Figure 2 omitted)

DMS-HLR

In addition to the DMS-MSC and its associated VLR, the other key network element that Northern Telecom and BNR are developing for GSM is the DMS-HLR--the centralized database for storing subscriber data. In building the DMS-HLR, BNR clearly separated the three major components: the services software, the database software, and the MAP (Mobile Applications Part) interface.

The DMS-HLR services software and database software are essential for the delivery of services in a GSM network. For the DMS-MSC to be able to provide services, the DMS-HLR must have knowledge of those services and be able to download the provisioning information to the VLR associated with the DMS-MSC. In addition, because the DMS-HLR knows the subscriber's location and is involved in all incoming calls to mobile stations, it also implements certain services directly instead of only via provisioning data download. The DMS-HLR knows, for example, whether "call-forwarding unconditional" is active. As a result, when it receives a request to provide a routing number for an incoming call, it can return the forwarded number rather than a number that will route the call to the current MSC location. Similarly, if the subscriber has activated call-barring for all incoming calls (similar to a do-not-disturb feature), the DMS-HLR can inform the gateway MSC that call-barring is active, rather than route the incoming call.

GSM also uses the MAP signaling protocol to provide the intelligent signaling needed to support the exchange of location and service information between the DMS-MSC, DMS-HLR, and visitor location register. MAP--which is implemented on top of the CCITT Transaction Capabilities Application Part (TCAP) in the CCS7 protocol stack--is a new ETSI-specified protocol that uses some of the more advanced capabilities of TCAP, such as conversation support.

These advanced capabilities are required to manage the complex transactions needed to support the DMS-HLR's role as master of the network data. By contrast, current Intelligent Network applications, such as Freephone (an example of which is Enhanced-800 service), require only query-response transactions, which are updated from the administration data center owned by the network operator. (In query-response, the transactions consist of two messages: the query to the database and the response. These types of transactions require no memory on the part of the node being queried: once the response has been sent, the dialog ends. Conversations, on the other hand, can have many message exchanges within the transactions. During the message sequences defined in GSM, for example, the nodes must keep track of where they are in dialogs with other nodes. Box 3 describes the dialog required at the HLR for location updating and call routing. Each procedure involves multiple messages between two nodes, as well as intermediate queries to other nodes (getting the routing number and cancelling old locations).)

To "future-proof" the software for Northern Telecom's GSM network elements, BNR is basing the software architecture on the same design principles used in the DMS-100 Advanced Intelligent Network (AIN) product now under development. As a result, the DMS-MSC and DMS-HLR will be able to evolve to Northern Telecom's AIN platform and services as AIN standards and capabilities emerge. This evolution will enable the DMS-MSC and DMS-HLR to provide future additional services--such as screening based on time of day or location--that are not part of the current GSM standard.

SUPPLEMENTARY SERVICES

More immediately, however, the combined capabilities of the DMS-MSC and DMS-HLR will enable the delivery of services beyond basic telephony. These supplementary services, which are based on those defined for ISDN terminals, include call forwarding (unconditional, subscriber busy, subscriber not reachable or not responding to a page, and subscriber not answering), calling number and connected-number presentation, call barring, multiparty calls, and call-waiting.

Supplementary services can be provisioned in one of two ways: by the GSM network operator updating the subscriber profile in the DMS-HLR; or by subscribers setting up or modifying their service profiles from their mobile stations. The second procedure takes advantage of the CCS7-based signaling protocols for exchanging messages between the mobile station, DMS-MSC, and DMS-HLR. Actual activation of the services requires functional ISDN-style messages, which specify precisely the subscriber's request. This procedure also could include a password sequence to ensure security.

DATA SERVICES

GSM also uses the advantages of digital cellular technology to provide data services. The point-to-point, short message service (SMS), for example, will enable GSM mobile stations to send or receive text messages of up to 160 characters in length. This service functions much like an integrated phone and text pager, but also allows users to send and receive text messages. Like a voice-messaging system, the short message service will require the DMS-MSC to interwork with a GSM service center--a network node that provides message storage and retrieval. If the service center is unable to deliver a message, it asks the HLR to inform it when the mobile station becomes available to receive the message.

In addition to the short message service, the DMS-MSC also interworks with external data devices to provide synchronous and asynchronous data services to personal computers or facsimile machines attached to the mobile station. These digital data interworking functions operate similarly to a modem, converting the radio-link protocols to data protocols used in the public switched telephone network. Digital technology, however, provides more robustness, better reliability, and higher speeds.

GSM EVOLUTION

GSM standards have matured throughout the 1980s and now define a complete digital cellular system architecture, with open interfaces that allow components from multiple manufacturers to interwork. These standards have been selected for use by the European Community and the signatories to the GSM memorandum of understanding. Several other network operators worldwide have adopted the GSM standards for use in their networks.

While specific to a digital cellular implementation, the GSM standards represent the most advanced specifications for the ubiquitous provision of

the mobility features that are fundamental to the realization of Personal Communications Services (PCS). These features include location tracking and mobile call routing.
To provide true access-independent and location-independent services, PCS must be built on standards that enable networking both within and between networks. The GSM standards create an excellent opportunity for the telecommunications industry to gain significant experience in how best to achieve such networking.

With an eye to the future, BNR has created an architecture for Northern Telecom's GSM products that adds mobility services to the DMS SuperNode platform in such a way that permits them to be reused in other applications, such as PCS, as standards evolve. With this flexible architecture, Northern Telecom and BNR's GSM development provides the basis for the creation of mobility systems to support large-scale PCS networks.

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Michelle Beaudry received a Bachelor's degree in computer science from Laurentian University (Sudbury, Ontario) in 1983. Upon graduation, she joined BNR in Ottawa and worked on various projects related to the evolution of the DMS SuperNode operating system, including portability, messaging services, and multiprocessor support. She was also the manager responsible for DMS-Core call-capacity and call-processing support software. In 1989, Ms. Beaudry transferred on assignment to the BNR lab in Maidenhead, U.K., as manager for wireless, GSM, and Intelligent Network planning for Europe and the Pacific Rim. She is currently senior manager of the BNR Europe GSM development team.

Jerry Parker obtained a B.Sc. in mathematics in 1968 from San Jose State University (California) and an M.Sc. in computer science in 1970 from the University of Missouri. Upon graduation, he developed telecommunications software products for NASA and the Federal Reserve Bank. He joined BNR in 1981 as a member of scientific staff, working on DMS-250 call processing. The following year, he joined the DMS-MTX cellular call-processing team, and in 1984, was promoted to manager, advanced cellular design, responsible for remote cellular switching products. In 1986, Mr. Parker provided CCS7 and ISDN development planning for DMS-250 interexchange carrier network products, and in 1988 worked on SL-100 architecture analysis for switch-computer products and wireless customer premises equipment devices for PCS. He was promoted in 1990 to his present position as senior manager, systems/software architecture development, responsible for development of system and software architecture for the GSM digital cellular DMS-MSC product.

Paul Van Oorschot received a Bachelor's degree in mathematics in 1984, a Master's degree in the same discipline in 1986, and a Ph.D. in computer science in 1988, all from the University of Waterloo (Ontario). He joined BNR in 1988 as a member of scientific staff, working on the messaging base for Series 3 peripherals in DMS software. In 1989, he became a member of BNR's secure communications team, where he contributed to the design and

development of cryptographic aspects of the PDSO encryption/authentication product. Dr. Van Oorschot currently holds the position of advisor, cryptographic systems, and provides cryptographic consulting throughout the tricorporate. Currently, he is focusing on the security aspects of GSM product development and ISDN. In addition, he is an adjunct research professor with the school of computer science at Carleton University (Ottawa), teaching a graduate course in cryptography.
Since the writing of this article, Northern Telecom has formed a joint venture with Matra Communication of France for the sales and marketing of GSM cellular systems.

BOX 1. GSM SYSTEM ARCHITECTURE

Developed by a standards body within the European Telecommunications Standards Institute (ETSI), the GSM (Global System for Mobile Communications) standards detail the specifications or a complete digital cellular network--including the architecture, components, and messaging protocols.

The major components include the mobile stations, base station system (which includes the base transceiver station and the base station controller), mobile-services switching center (MSC), home location register (HLR), visitor location register (VLR), authentication center, and equipment identity register.

The mobile stations (the cellular handsets) enable subscribers to communicate with the GSM network, They are partitioned functionally and physically into two units: the mobile equipment, and the subscriber identity module (SIM) card.
The mobile equipment communicates with the base station system over the radio link, and implements the algorithm for radio-link encryption (see Box 2). The radio link operates in the 900-MHz spectrum over a bandwidth of 25 MHz, using frequency division duplex/time division multiple access (FDD/TDMA). The bandwidth of each radio carrier channel is 200kHz, providing eight full-rate TDMA channels today, and expanding to 16 half-rate channels in the future. Several features are used to improve the transmission quality and minimize interference. These features include frequency hopping, voice activity detection options, and mobil-assisted handover, which incorporates signal strength and bit-error-rate measurements.

The SIM card--about the size of a credit card--contains an integrated circuit that holds data about the subscriber. The user can remove the SIM card from his or her handset and insert it into any other GSM handset, thus retaining access to his or her personal service profile no matter which GSM handset is used or to whom it belongs. Any GSM handset, therefore, can be customized with the characteristics of a particular subscriber.

The second major component--the base station system--communicates with all GSM mobile stations in its coverage area. (The coverage area typically consists of one to eight cells, depending on the cell size and traffic loads.) The base station includes: one or more base transceiver stations, which handle radio communication with the mobile stations; and a base station controller, which manages the base transceiver stations, as well as handover, encryption, and the interface to the mobile-services switching center (MSC).

The MSC, in turn, performs switching, routing, call-control, charging, and accounting functions. It also delivers to mobile subscribers such supplementary GSM services as call-forwarding and call-barring, which are similar to those provided in an ISDN switching node. The MSC interworks

with the network databases--such as the HLR, the VLR, the authentication center, and the equipment identity register--to track mobile stations and process calls in its own area and to other mobile exchanges, as well as to the public switched telephone network.

The HLR provides the centralized database for storing information associated with each mobile user. This information includes the user's service profile, location, and subscription and billing options. The VLR, on the other hand, provides a database for retrieving, administering, and temporarily storing subscriber data when a subscriber roams into its serving area. Although functionally separate within the GSM architecture, the VLR and the MSC typically are co-located and support the same serving area.

When a mobile station enters an area served by an MSC, data on the particular subscriber and mobile station is downloaded from the HLR to the VLR associated with that MSC. The MSC can then retrieve that data from the VLR to process calls to the mobile station.

The authentication center generates encryption keys and security-related parameters that the MSC uses to challenge mobile users to verify that they are authorized to use the system. These authentication and encryption control procedures minimize fraud and provide the increased level of privacy necessary for radio communications. Similarly, the equipment identification register generates data--such as lists of bad or stolen mobile equipment--to guard against the fraudulent use of equipment.

In the GSM network, the HLR, authentication center, and equipment identity register are usually centralized. VLRs, on the other hand, are distributed throughout the network, each one usually associated with an MSC.

With this two-tier hierarchical arrangement of centralized and distributed databases, GSM efficiently distributes data to the network elements as they need it. In this way, subscriber provisioning data is removed completely from individual switching systems and is centralized to give all switches equal access to the information, thereby making efficient use of network resources and optimizing network performance.

The operations and maintenance center provides dynamic monitoring and control of operations and maintenance over its geographic area, and interacts with a network management center, overseeing the entire GSM network. In current implementations, these operations and maintenance centers are frequently subdivided into centers for the base station systems and the MSCs.

OPEN INTERFACES

The GSM standards specify that the interfaces between these network elements be open to allow equipment from multiple vendors to interwork.

These interfaces include:

* the Mobile Application Part (MAP) protocol, which is implemented on top of the CCS7 Transaction Capabilities Application Part (TCAP) and is used to exchange location and service information between the MSC, the HLR, and the VLR;
* the A-interface, which is based on PCM-30 with CCS7 MTP (Message Transfer Part) and SCCP (Signaling Connection Control Part) and a modified ISDN Q.931 layer running above that;

* the A-Bis interface, which is used between the base station controller

and the base transceiver station, and is based on a 2 Mbit/s PCM-30 transmission link and Q.921 link access protocol D (LAPD), the CCITT layer 2 ISDN signaling protocol; and

* the Um air interface standard, which is used between the mobile stations and the base station systems, is based on the GSM TDMA cellular standard and uses the modified ISDN Q.931 interface for call control.

BOX 2. GSM SECURITY FEATURES

To provide GSM (Global System for Mobile Communications) subscribers and network operators with the same level of privacy and security they have come to expect from wireline networks, Northern Telcom and BNR are implementing a GSM authentication center database function on Northern Telecom's DMS SuperNode switching platform. This authentication center, which is part of the DMS-HLR (home location register), generates and administers the security-related parameters needed to "challenge" mobile subscribers to verify that they are authorized to use the system, and to encrypt subscriber data to provide privacy over the air interface.

BNR's cryptography specialists are working closely with the product development team to ensure that the authentication center--the cornerstone of security for the entire GSM network--is cryptographically strong. Cryptography--the most fundamental tool of communications security--is used to transform signals into a form that is unintelligible. The transformation is carried out under the control of secret keys--that is, sequences of symbols that vary from system to system (from less than 100 to more than 1000 bits in length). These symbols are generated using computer algorithms.

The relationship between encrypted messages and their keys is very much like that between locks and keys. Just as a lock can be opened by the right key, an encrypted message can be decrypted with the right key. Good cryptographic systems are designed in such a way that any attempt to decrypt a message using the wrong key--no matter how small the error--results in a meaningless jumble.

To ensure security and privacy features in a GSM network, BNR's cryptographic expertise is being used to develop the GSM-standard and customer-specified algorithms that are integral to the encryption and authentication processes. These algorithms will provide the appropriate level of security, without, for example, affecting the real-time con-straints of the network during call-setup.

The authentication keys and cryptographic algorithms are essential to safeguarding communications in cellular networks. Indeed, unless precautions are taken, the radio technology that brings the convenience of mobility to millions of subscribers can be susceptible to fraudulent use of network resources and threats to privacy.

SECURITY RISKS

The most obvious security risk is the radio link's vulnerability to eavesdropping. Using commercially available scanners, eavesdroppers can easily scan radio waves to intercept conversations; in conventional wireline systems, they would have to physically tap the telephone lines. The consequences can be much more damaging than merely listening in on ordinary conversations. Eavesdroppers, for example, could gain access to a subscriber's calling-card or credit-card numbers--information that the network operator may be legally liable to protect.
The second security threat is fraudulent access to telecommunications

services, whereby an unauthorized user gains access to network services under the guise of a legitimate subscriber or a fraudulent account. After gaining access, unauthorized users could, and indeed have been known to, resell network services, which in some cases could end up being billed to legitimate subscribers. The cost to network operators can be significant--such fraud is estimated to cost the U.S. cellular industry alone from $100 million to $700 million a year, according to estimates from different industry sources. Although the figure for Europe is hard to obtain because of the number of countries involved, it is believed that losses in Europe are comparable.

A third threat is related to the subscriber's right to protect the privacy of his or her location. Unless appropriate steps are taken, the subscriber's geographical location can be determined by scanning radio waves, homing in on the source of radio transmissions, and associating the source with a particular subscriber through the signaling information. For example, information obtained by monitoring registration, call-setup, or paging messages can be used to uniquely identify a specific subscriber in many cellular systems.

A related threat is unauthorized call auditing, whereby an adversary attempts to keep track of calls originating from or terminating at a specific handset in order to gain information on calls involving the subscriber. This information, for example, could reveal the identity of the party to whom a person has talked and at what time.

A fifth threat is unauthorized use of a handset itself, perhaps as a result of theft. Such use, which may be either temporary or longer-term, results in toll charges to the legitimate subscriber. Due to the portability of wireless handsets, unauthorized use is a far greater threat in cellular systems than in wireline-only systems.

GSM SECURITY FEATURES

In the absence of appropriate countermeasures, these threats could negate the convenience of the high-quality mobile communications that attract subscribers to cellular communications in the first place. To counter these threats, the GSM standards specify the following basic security features:

* subscriber confidentiality;
* personal identification numbers (PINs);
* encryption of subscriber data, voice, and signaling information; and
* subscriber identity authentication.

To provide the first feature--subscriber confidentiality--users are automatically issued a temporary mobile subscriber identity (TMSI) when they enter a new area and register for service. The TMSI--which is changed periodically while the subscriber remains in the area--is used over the air interface in place of the permanent international mobile subscriber identity (IMSI), which uniquely identifies a GSM subscriber to the network and is used for billing purposes. The TMSI is broadcast when the subscriber registers for service in a new area. Using a temporary identifier instead of the permanent IMSI makes it more difficult for eavesdroppers to track the location of subscribers and audit their calls. TMSIs are used by a mobile-services switching center (which, among other things, switches and routes calls from the public switched telephone network within the GSM network) and are mapped onto IMSIs on the network side.

The second security feature--PIN protection--prevents unauthorized use of a

handset if it is stolen. In GSM, the mobile station (or handset) is partitioned logically into two units: the mobile equipment, which provides the radio interface to the network and implements the algorithm for radio-link encryption; and the subscriber identity module (SIM) card (a "smart card" about the size of a credit card). which has an embedded integrated circuit that contains a microprocessor and subscriber-specific and network-specific authentication information, such as the IMSI and subscriber authentication key. Subscribers can remove the SIM card from the handset, for security reasons, when not in use or for use in GSM handsets other than their own.

The SIM itself is protected by an optional PIN, which can be altered by the subscriber. If PIN protection is enabled, a user must "unlock" the SIM by correctly entering a four-digit number before the handset can be used. The PIN, therefore, is used to authenticate the user to the handset. Once the SIM is active, it uses the internal subscriber-specific authentication key (Ki) to authenticate the handset to the network.

Three cryptographic algorithms--called A5, A3, and A8--are required to implement the other two major security features in GSM: encryption of subscriber data, voice, and signaling information for transmission over the air interface, which precludes eavesdropping and unauthorized call auditing; and subscriber identity authentication, which ensures that only authorized subscribers are granted access to network services.

GSM ALGORITHMS

Algorithm A5 is currently a fixed GSM-standard algorithm used by all operators; algorithms A8 and A3 are specified by the network operator. The GSM standards body offers default A8 and A3 algorithms, and BNR's cryptographic specialists are developing a number of A8 and A3 algorithms from which operators can choose. BNR is also working with individual operators to develop proprietary algorithms tailored to their needs. Diagrams A and B illustrate the external specifications of these algorithms.

Algorithm A5 is used to encrypt data, voice, and signaling information over the air interface, and is implemented in the handset and at the base transceiver station. The A5 algorithm generates encryption masks (strings of bits), one for the outgoing data stream and one for the incoming data stream. These masks are used to encrypt and decrypt radio interface data to ensure confidentiality.

Algorithm A8 is executed for each call independently by the handset and authentication center to generate a ciphering key (Kc). The Kc computed by the authentication center is sent to the visitor location register. The mobile-services switching center retrieves Kc from the visitor location register and forwards it to the base transceiver station, where it is stored for subsequent use by the A5 encryption algorithm in the base station.

Algorithm A3 is used to carry out authentication of the mobile subscriber. The authentication procedure is based on the subscriber-specific authentication key (Ki), which is stored both in the authentication center and in the SIM card in the handset.

Diagram C illustrates how this information is used in operations, such as location updates and call-setup, where authentication is required. (Diagram C omitted) When a mobile station enters an area outside its home subscription area, the visitor location register associated with the mobile-services switching center in the new area initiates a protocol that extracts the mobile's temporary identity, which is associated with an IMSI,

allowing identification of the mobile as a visitor (step 1).

The network authenticates a subscriber by challenging a handset to prove it knows the subscriber's secret authentication key (Ki), without transmitting it over the air. It does this with the A3 algorithm, using the following procedure. The authentication center generates a random number (RAND) and computes an expected subscriber response (SRES). The SRES is the value obtained when the random number and authentication key (Ki) are used as parameters to A3. The RAND and SRES are then downloaded to the visitor location register (2).

When the mobile station requests access to the network, the network challenges the mobile with the random number (3). The SIM in the handset uses the random number, in conjunction with the stored authentication key and authentication algorithm A3, to compute its response SRES' (4) to the challenge. The visitor location register checks to ensure that the SRES' resuff returned from the handset is equal to the SRES that it has stored (5). If they are the same, the user is granted access to the service; otherwise, the user is denied access.

BOX 3. GSM MOBILITY MANAGEMENT AND PERSONAL COMMUNICATIONS SERVICES

While GSM (Global System for Mobile Communications) standards are secific to digital cellular networks, they currently represent the world's most advanced specifications for providing mobility features--such as location tracking--that are fundamental to the realization of Personal Communications Services (PCS).

To be successful, PCS must bridge the gaps between access technologies (such as wireline, low-power wireless, and cellular), market applications (such as residental, corporate, and public), and different vendors' equipment to offer individuals a service tailored to their needs, wherever they are located. And, to enable this level of ubiquity, standards must be defined that will allow networkwide and internetwork cooperation.

The European Telecommunications Standards Institute's (ETSI's) GSM standards define the specifications for a complete digital cellular system, including the air interface, interfaces to base station controllers, cell control, and handover, among others. Particularly important for PCS are the network aspects for provisioning subscribers and their services, as well as for tracking their current location in the network.

As Diagram A shows, a GSM network comprises a number of serving areas, the sizes of which are determined by the capacity of the mobile-services switching center (MSC), subscriber density, and regulatory bodies, to name a few. (Diagram A omitted) Each serving area covers several contiguous cells and is served by an MSC and its associated visitor location register (VLR).

Linked to each MSC are a number of base station controllers, which control the base transceiver systems that provide the radio interface to the mobile stations. A centralized home location register (HLR) stores data on subscribers and mobile stations. When a subscriber enters a new serving area, the relevant data is downloaded to the VLR in that area. The MSC can then access this data to provide service to the subscriber. The GSM network also contains a gateway MSC, called the transit switching center, which is used when a call destined for a mobile station originates from a mobile, the public switched telephone network, a private branch exchange, or networks that do not have the ability to interrogate the HLR for subscriber information.

To better understand the relationships between these elements in the GSM network, the following examples describe the flow of information for two different operations that are essential requirements for any PCS network location updating and call routing.

GSM LOCATION UPDATING

Diagram B shows the message flow between key components in a GSM network as a mobile subscriber roams from cell to cell. (Diagram B omitted) In GSM, network operators can define location areas, which can be as small as the geographic area served by a single base transceiver system, or as large as an MSC's entire serving area.
When a mobile station crosses location area boundaries, it sends a location update request containing its identity to the VLR (step 1). If the VLR recognizes that it has data on the mobile user, it simply updates the data it holds. It uses this information to determine which cells should be paged on an incoming call. The VLR then acknowledges the location update to the mobile station (4).

If, however, the VLR has no existing entry for the mobile user (because the user has roamed into its area from another VLR area or has just powered up), the VLR sends a location update message (2) to the user's HLR. This message includes the identity of the user, as well as the identity of the VLR. The HLR notes the mobile subscriber's new location and downloads the mobile user's subscription data to the new VLR via a response message (3). The VLR acknowledges the location update to the mobile station (4).

If the HLR has a record that the mobile subscriber was registered previously at another VLR, it will also send a location cancellation message to the old VLR to clear the data there (5). A mobile subscriber is known only to one VLR at a time (other than during a location updating sequence). The HLR is always the master of the data, and coordinates all data changes.
GSM CALL ROUTING

Diagram C illustrates the role of the gateway mobile-services switching center as the interconnect point with the public switched telephone network. The gateway MSC--which contains functionality very similar to that of the service switching point (SSP) in an Intelligent Network--queries the HLR to determine where to route calls.

The diagram depicts the message flow required to terminate an incoming call from the public switched telephone network to a mobile subscriber. The network first recognizes from the dialed digits that the call is to be routed to a gateway MSC (step 1).

Based on the dialed digits, the gateway MSC recognizes that it cannot route the call further, but must interrogate--via a CCS7 TCAP (Transaction Capabilities Application Part) request--the called mobile user's home location register (2). The HLR then interrogates the visitor location register that is currently serving that subscriber (3). The VLR returns a routing number to the HLR, which passes it on to the gateway MSC (4).

Based on the routing number it reeives, the gateway MSC routes the call to the terminating MSC (5), using standard network routing capabilities. The terminating MSC asks the VLR for the information that will enable it to correlate the incoming call on this routing number with the identity of the mobile subscriber to be paged (6). Once the identity of the terminating mobile subscriber is determined (7), the MSC completes the call (8).

STANDARDS EVOLUTION

While the GSM architecture provides capabilities for location updating and mobility management, GS$M is defined in a manner that is very specific to the European digital cellular networks--the detailed structures of the databases and messages may not be directly reusable in other network environments, such as PCS.

Recognizing the need to expand its activities beyond a specific digital cellular application, the GSM standards group within ETSI recently refocused its standardization efforts toward more generic mobility specifications. This new direction is reflected in the renaming of the GS$M standards group within ETSI to the Special Mobile Group (SMG), in which BNR is an active participant.

Eventually, the capabilities of the service-independent Advanced Intelligent Network (AIN) will enhance the basic GSM model with more generic mobility management capabilities that can be reused in environments other than digital cellular. For service providers, the AIN architecture will provide a high level of interworking between PCS applications, ultimately enabling the bridging of PCS islands of technology from different vendors and different application environments.

Near-term AIN specifications for a range of services are currently being defined by the CCITT (International Telegraph and Telephone Consultative Committee) in Capability Set 1 (CS-1), which includes PCS specifications. BNR is also a very active contributor to this group.

For smaller PCS application environments, such as corporate networks, other standards are being defined by the American National Standards Institute (ANSI) in North America and the European Computer Manufacturers Association (ECMA) in Europe. Known as Switch-to-Computer-Applications Interface (SCAI) in North America and Computer-Supported Telecommunications Applications (CSTA) in Europe, these standards will enable PCS applications that bridge the computing and telecommunications environments. The standards are based on concepts very similar to AIN: triggers in the switching element and protocols to allow intelligent communication between the switching element and computer-based applications. The SCAI/CSTA standards create the foundation for scaling PCS down to sizes suited to a very wide range of telecommunications providers.

Activities have also begun within the CCITT for the standardization of Universal Personal Telecommunications (UPT) to provide personal telecommunications services that are portable across any network environment. These activities began in 1990, with the goal of reaching standards by 1996. The UPT architecture, which is based largely on the capabilities of AIN, is taking advantage of the knowledge gained in the definition of GSM.

PCS network

A current example of how GSM can be used to offer early PCS-type services is the Personal Communications Network (PCN), a mobile telephony system concept the British Department of Trade and Industry initiated to create competition for existing mobile and landline service providers. Three PCN licences were granted in the U.K. at the end of 1989, with licence holders agreeing that PCN would be based on GSM standards but would be implemented in the 1800-MHz range instead of in the 900-MHz range of the GSM standard radio interface.

PCN is basically a mass-market radio telephony system, offering standard POTS (plain ordinary telephone service), together with a range of

value-added services, such as calling-line identification. Instead of GSM cellular handsets. PCN uses lightweight, low-power mobile stations that can be carried and used anywhere --in buildings, cars, and, eventually, high-speed trains.

The lower power of the PCN mobile stations--ranging from 250 milliwatts to 1 watt, compared with 800 milliwatts to 20 watts in GSM mobile stations--will encourage the creation of much smaller cells, less than one-quarter the size of current GSM cells. To alleviate high-density usage and congestion at transceivers, however, even smaller microcells can be overlaid on the basic cell network. These microcells may cover a range as small as 150 meters in diameter (compared with cells of 1,000 to 15,000 meters in GSM). Eventually, another network of even smaller cells, called picocells, may be developed to serve such very small areas as a building or train.

In the future, it is expected that the Special Mobile Group of ETSI will study aspects of personal communications, such as microcells, that will further differentiate PCN from cellular systems, as well as investigate the sharing of infrastructure, such as home location registers, base stations, and the mobile-services switching center, between PCN and GSM cellular networks.

BOX 4. BNR DEVELOPS UNIQUE TOOL FOR SIMULATING GSM NETWORKS

BNR and Northern Telecom have develop one of the world's first software simulation tools that can model and assess the performance of cellular radio telephone systems in such outdoor environments as vehicular and sidewalk pedestrian applications. This new simulation tool models systems that conform to the European Global System for Mobile Communications (GSM) digital cellular radio standards. (Through changes to its modular software, the simulator can also emulate standards used in North America, such as time division multiple access 30 (TDMA-30).)

The simulator will enable cellular companies to assess the performance of candidate systems--such as proposed cellular islands of Personal Communications Services (PCS) systems--in a simulated environment before finalizing specifications or deploying hardware in an actual system.

Computer simulation of cellular network performance is an important network design technique, because actual trials of large systems are too costly and time-consuming to be feasible. Before network analysis tools like the simulator were developed, performance models of large cellular networks were generated either through extrapolation of historical data or through trials on customers' networks of small prototype systems. The results of these trials were then extrapolated to create a performance model for a large cellular system.

In contrast, the simulator delivers, in advance of deployment, precise information about the specific system modeled. For example, the simulator can determine the distribution of interference levels on a model system by analyzing such parameters as base station placement, channel allocation for each base station, distances between base stations, and the propagation environment.

The simulator's main focus is on system-level issues, such as the effect on performance of channel allocation, power control, and handover techniques. For example, it can explore ways to reduce handover requests without increasing the chance of calls being dropped.

The simulator assesses system performance from several angles. It measures

such grade-of-service aspects as failed call attempts and interference from other system users, and averages this data over many calls to indicate how the system would perform when implemented. Cellular network designers can then use this date to fine-tune GSM networks for maximum capacity and optimum grade of service.

To help designers address these issues efficiently, the simulator displays performance data on a Sun workstation in full-color graphics, enabling designers to make intuitive interpretations of simulation results. Using this graphic display, designers can see patterns of performance statistics, then zoom in to examine the data in detail.

BNR designers plan to use the simulator to create simulations of customers' proposed digital cellular systems. In this customer support role, the simulator's large body of performance statistics will provide a reliable, system-level view of a large cellular system with many base stations and mobile radio units. After customers use this data to refine their network models, they can resubmit the improved models to BNR, evolving system design through successive simulations.

BNR's DEVELOPMENT OF THE SIMULATOR

The development of the simulator began in early 1990, when the United Kingdom's Department of Trade and Industry asked BNR's Harlow laboratory to join a collaborative program with other industry and academic bodies. BNR's mandate was to develop a simulator for the design of PCS networks operating on GSM standards in an outdoor environment. The project was completed in mid-1992.

In developing the simulator, BNR relied on its experience in developing Northern Telecom 1 800-MHz cellular base stations, which operate on a version of GSM. Because large call-simulation tools for cellular radio systems did not exist when the simulator project began, BNR engineers faced several challenges.

The first challenge was to develop the simulator in parallel with GSM standardization and implementation. In 1990, GSM networks were yet to be deployed and their standards had not been finalized. Consequently, the early development of the simulator was based on BNR designers' participation in the GSM standards forum and on their understanding of existing Total Access Communications System (TACS) analog cellular networks. (TACS is the European equivalent of North America's Advanced Mobile Phone System (AMPS) analog technology.)

This experience provided BNR designers with a good understanding of how the deficiencies of TACS systems were being addressed in GSM standards. Their main concerns were interference and handover --areas in which digital cellular technology offered considerable improvements over analog technology by reducing the number of calls dropped during handover, and by reducing the effects of interference on call quality.

The second challenge was to think about radio technology in new ways. For example, although traffic theory is well-known in BNR's development of wireline switches, it is a relatively new radio concept. Traditional radio systems, such as long-haul systems, are designed for point-to-point communication over dedicated channels. Cellular traffic theory, in which many mobile units compete for a pool of channels, introduced such new radio concepts as call blocking.

BNR developed the simulator's call blocking simulation capability through the use of statistical thresholds and parameters that approximate actual

calling activity. For example, when a simulated mobile radio unit attempts to call the nearest base station, the simulator considers the call blocked if a free channel is unavailable or if a channel with a low level of interference --assessed by measuring the channel's carrier-signal-to-interference (C/I) ratio--cannot be found. If the C/I ratio is greater than a given threshold--typically 11 decibels (dB) for a digital system--the simulator allocates the channel.

The third challenge was streamlining the simulator's program, which is large--about 8,000 lines of code--and complex because it uses a technique called Monte Carlo simulation. This technique randomly generates and tracks many individual events for about 2,000 simulated calls at any moment. The simulator then collects the data at the end of the simulation process, and graphically displays a summary of results. To minimize simulation time, BNR designers are constantly optimizing the simulator's routines.

FLEXIBLE DESIGN CAPABILITIES

Because this complex simulation program is intended for network analysis (rather than detailed systems planning), it is designed to function in a generic, "featureless" landscape. The simulator assumes that general statistics of fading and shadowing apply to all system applications. Specific planning details, such as the placement of base stations in relation to tall buildings, are best handled by available low-level planning tools.

This generic approach enables one of the simulator's greatest strengths the ability to simulate a wide variety of conditions and applications. The simulator is adaptable because it is based on an empirical propagation model, called the Hata model, which enables designers to simulate rural, suburban, and urban propagation scenarios by changing parameters in the model.

In addition, the tool simulates urban shadowing conditions through the use of another model, called a log-normal distribution model, which assesses a variety of standard deviations for shadowing from a specified norm. Shadowing occurs when radio signals are reflected from obstacles, such as office buildings. The greater the deviation, the more congested the environment, and the more random the shadowing. London, for example, has a standard deviation of 6.5 dB; Tokyo, a more congested city, has a standard deviation of 9 dB. Similar variations are possible for suburban and rural environments.

The Hata model is designed for the high-power macrocellular technology used in vehicular cellular systems. The simulator uses a separate, similar propagation model to adapt simulations to the low-power, microcellular technology of pedestrian cellular systems.

BNR has enabled the tool to simulate both high-and low-power cellular systems by developing software that is compatible with existing 900-MHz digital cellular standards, used for macrocellular structures, and with 1800-MHz frequency standards, called DCS-1800. A version of GSM, DCS-1800 will enable future personal communications networks in the United Kingdom to use low-power radios.

The simulator's dual-standard compatibility enables it to simulate the interworking of low-and high-power cellular systems, which differ in their antenna heights, channel allocation, and handover algorithms.

Because the simulator combines both technologies on the same platform, it is well-suited to the design of personal communications networks, which are

likely to incorporate low-and high-power cellular systems in the same network. In developing the simulator. BNR designers took into account the evolving PCN (personal communications network) environment in the United Kingdom. In London, for example, high subscriber density and user demand for the mobility and availability of portable low-power handsets have spurred the development of cellular services in low-power "sidewalk" applications.

These applications typically will involve delivery of cellular service to lamp-post-mounted antennas from base stations providing a relatively low number of channels within small cells (with radii of a few hundred meters). This microcellular architecture, planned for many European cities, provides "spot" coverage in dense areas, such as railway stations. Spot coverage is complemented by an "umbrella" of high-power macrocells, based on antennas that are 30 meters in height and on cells that have radii of a few kilometers. This umbrella covers vehicular mobile units and portable handsets roaming beyond dense areas.

DYNAMIC, DETAILED GRAPHICS

Another strength of the simulator is its color-graphic display, which enables network designers to view simulation results and make intuitive assessments of patterns in GSM network behavior. For example, users can view networkwide patterns of call-setups, closings, or interference.

This intuitive view of network performance can reveal critical information missed by traditional modeling techniques, which simply report one average number for each base station.

For example, although the average call-blocking rate for a base station is low, this average may hide the fact that most blocked calls are concentrated at the cell boundary. Cellular subscribers in these boundary areas may, in fact, be experiencing individual call-blocking rates as high as 20 percent and may be having difficulty receiving channels. The simulator's graphic display instantly reveals such unbalanced call-blocking distribution.
Similarly, an averaged report from the cellular mobile units served by a base station may indicate a normal spread of power output--for example, between 10 milliwatts and 2 watts. If most mobile units are operating on maximum power, however, the system's power control algorithm is not working optimally; the mobile units are consuming excessive power.

After designers identify patterns, they can zoom in for detailed examination. The simulator displays results geographically by averaging them within small grid regions (representing 50-or 100-meter squares), as well as for each base station.

Variations in traffic distribution are specified in Erlangs per square kilometer. This additional measurement, which is used to generate appropriate numbers of calls per grid, enables high-traffic areas to be defined independently of general user mobility.

FUTURE CAPABILITIES

Because the simulator helps GSM network designers address such issues as power control, call blocking, and handover, it is well-positioned to play an important role in helping cellular operators plan future PCS networks. In the future, the simulator will be the system level component of a family of cellular system design tools now being developed by BNR in collaboration with other vendors in the United Kingdom, In addition to the existing simulator, this family will include:

* an air-interface simulator, which will provide a complete simulation of PCS radio channels and provide essential bit-error-rate information to enable assessment of speech quality;

* a speech test bed, which will emulate, in hardware, a real-time speech link, assessing such factors as speech coding, error mitigation, and echo control by monitoring bit-error patterns generated by the air-interface simulator, or by real systems; and

* a Digital European Cordless Telecommunication (DECT) test bed, which will provide a bidirectional speech link for subjective assessment of low-power call quality, and will store such trial data as bit errors involved in call-setup, maintnance, and closing.

By sharing data generated by all four of these components, through a common interface provided by the speech test bed, system designers will be able to create a total, integrated view of the performance of future PCS networks. THIS IS THE FULL-TEXT.

- end of display -